Middle Potomac River Basin Summary

Final Version for 1985-2002 Data
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Middle Potomac Basin Characteristics

The Middle Potomac River Basin drains about 610 square miles, including portions of Montgomery and Prince George's Counties. Larger water bodies in this basin include Seneca, Rock, and Piscataway Creeks and the Anacostia River. The basin is located in the Piedmont Plateau and Coastal Plain physiographic provinces.

The 2000 census population for the Middle Potomac Basin was 1,388,000. The major city in the basin is Washington, DC; major Maryland cities in the basin include Rockville and Gaithersburg.

The Middle Potomac River basin is the most urbanized of the three Potomac tributary strategy basins. Land use in the basin is 55 percent urban, 16 percent agriculture, and 28 percent forest and wetlands. Given the large percentage of developed land, the major issues in the basin are point sources and urban loads.

As of 2002, the most significant contributor of nitrogen in the Middle Potomac River basin was point sources (52 percent) (Figure MPR3). Following that were urban sources (30 percent) and agriculture (13 percent). For phosphorus, the largest contributor was urban sources (60 percent), followed by point sources (17 percent) and agriculture (15 percent) (Figure MPR4). Urban sources were the dominant source of total suspended solids (46 percent) followed by agricultural sources (41 percent) (Figure MPR5).

A river input station (01646580) is located at Chain Bridge Road at the fall line near the northern Washington, DC border. Stream flow is measured one mile upstream at Little Falls. Most of the major wastewater treatment plants in the Washington, DC area discharge downstream of the river input station.

Figure MPR1 – 2000 Land Use in the Middle Potomac River Basin.

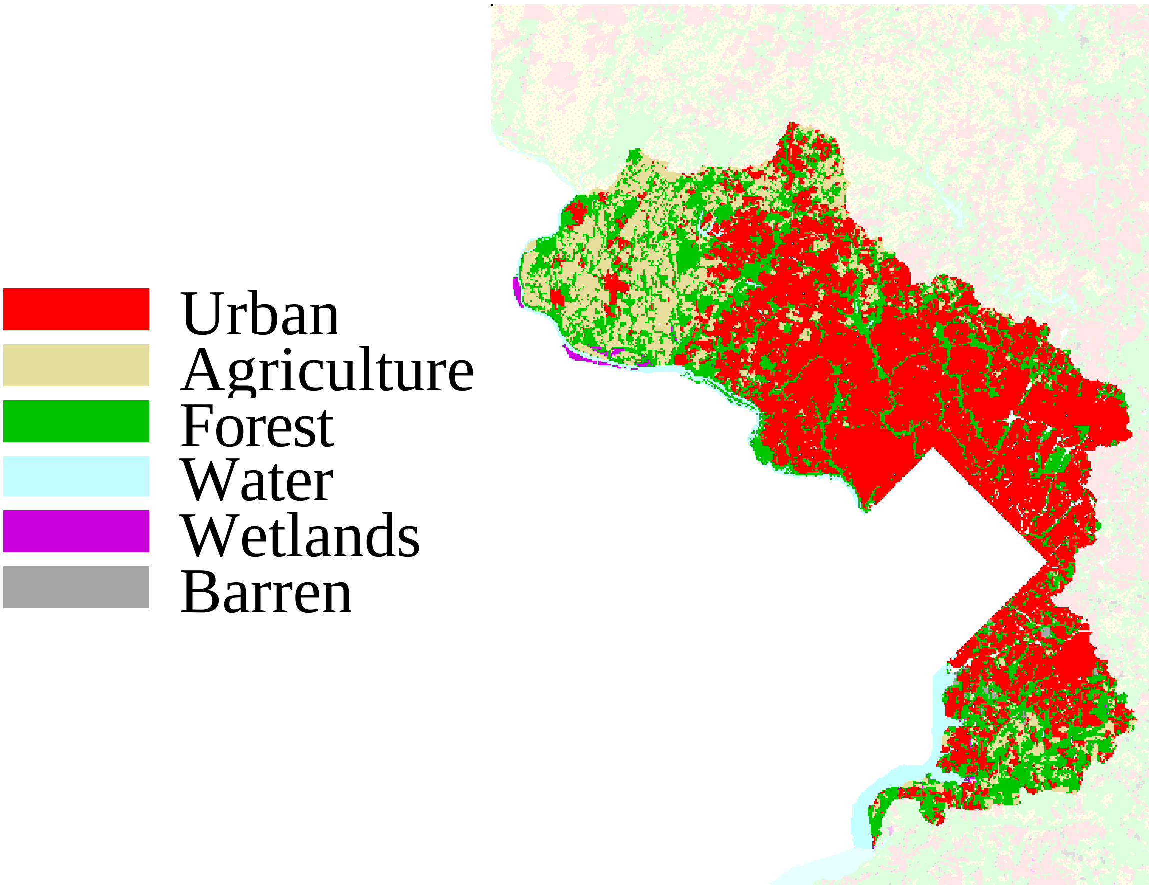


Figure MPR2 – Wastewater Treatment Plants in the Middle Potomac River Basin.

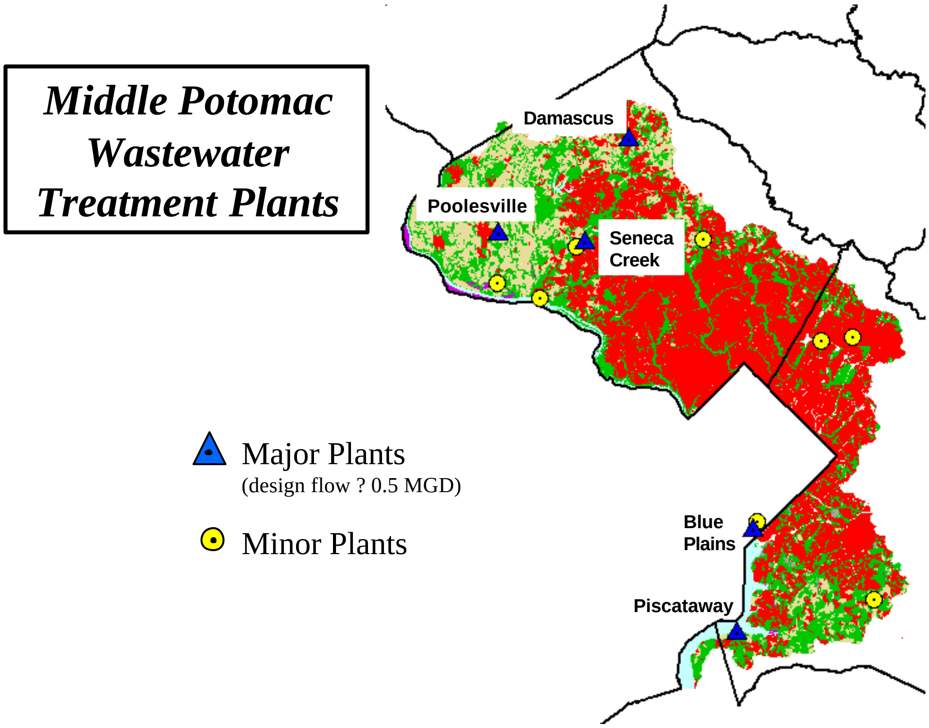
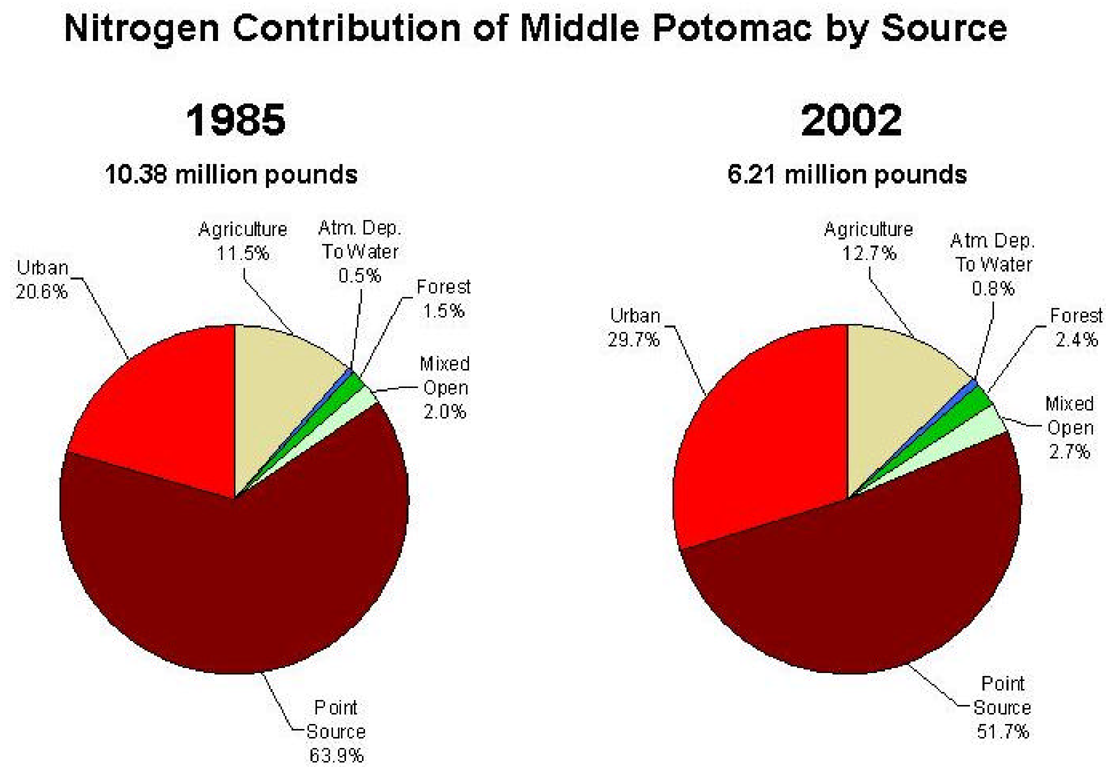
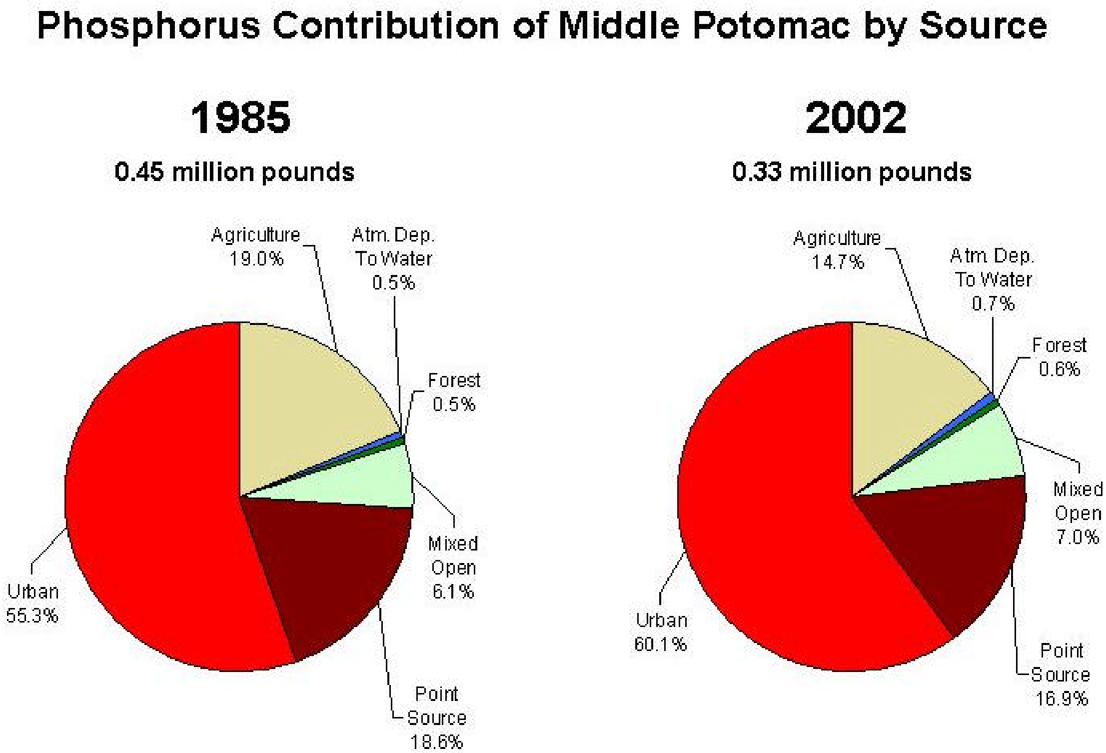


Figure MPR3 – 1985 Nitrogen Contribution to the Middle Potomac River Basin by Source.



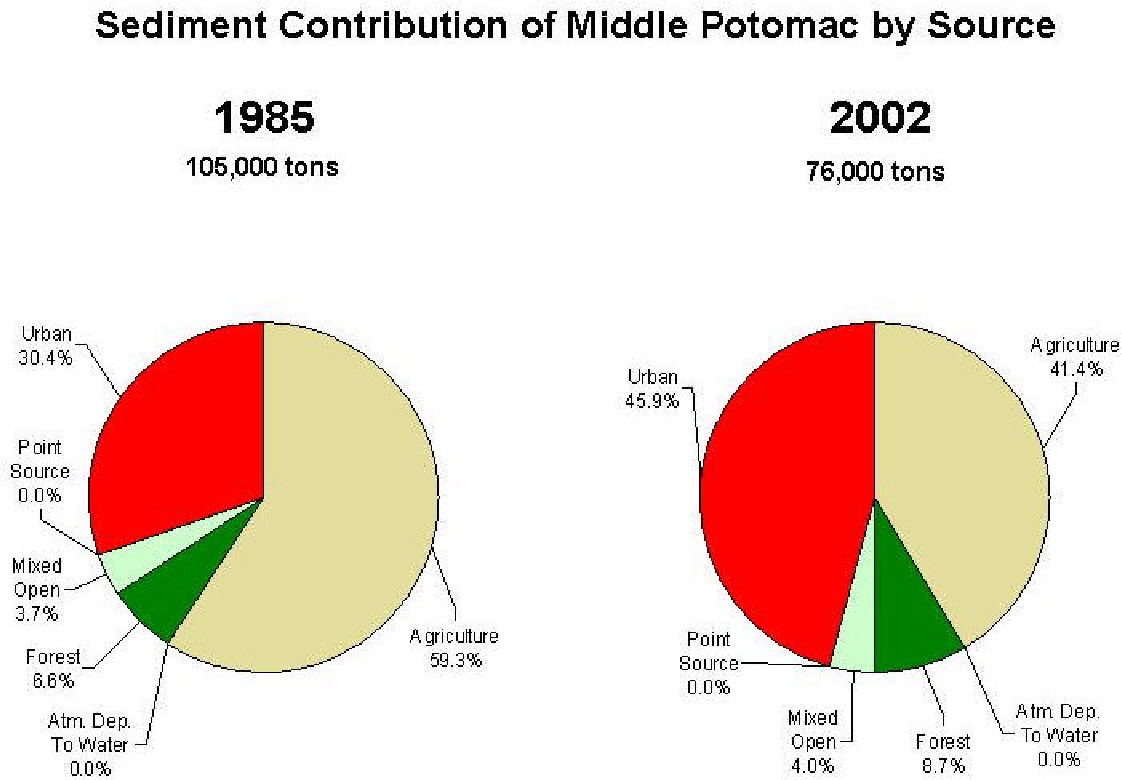
Source: Chesapeake Bay Program Phase 4.3 Watershed Model

Figure MPR4 – 1985 Phosphorus Contribution to the Middle Potomac River Basin by Source.



Source: Chesapeake Bay Program Phase 4.3 Watershed Model

Figure MPR5 – Total Suspended Solids Contribution to the Middle Potomac River Basin by Source.



Source: Chesapeake Bay Program Phase 4.3 Watershed Model

Figure MPR6 – Total Nitrogen Concentrations in the Middle Potomac River Basin.

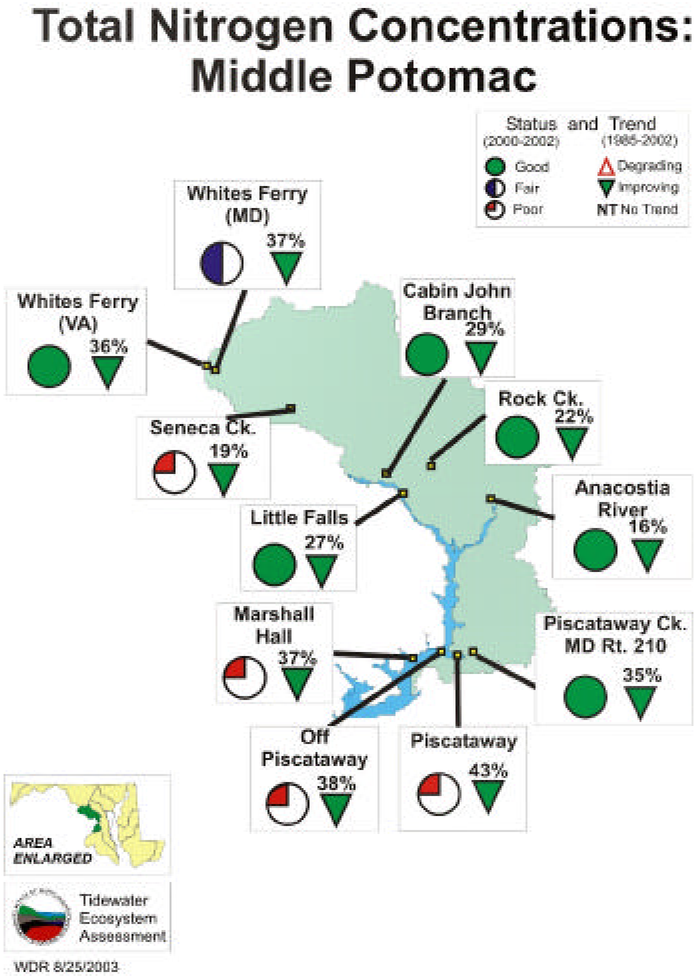


Figure MPR7 – Total Phosphorus Concentrations in the Middle Potomac River Basin.

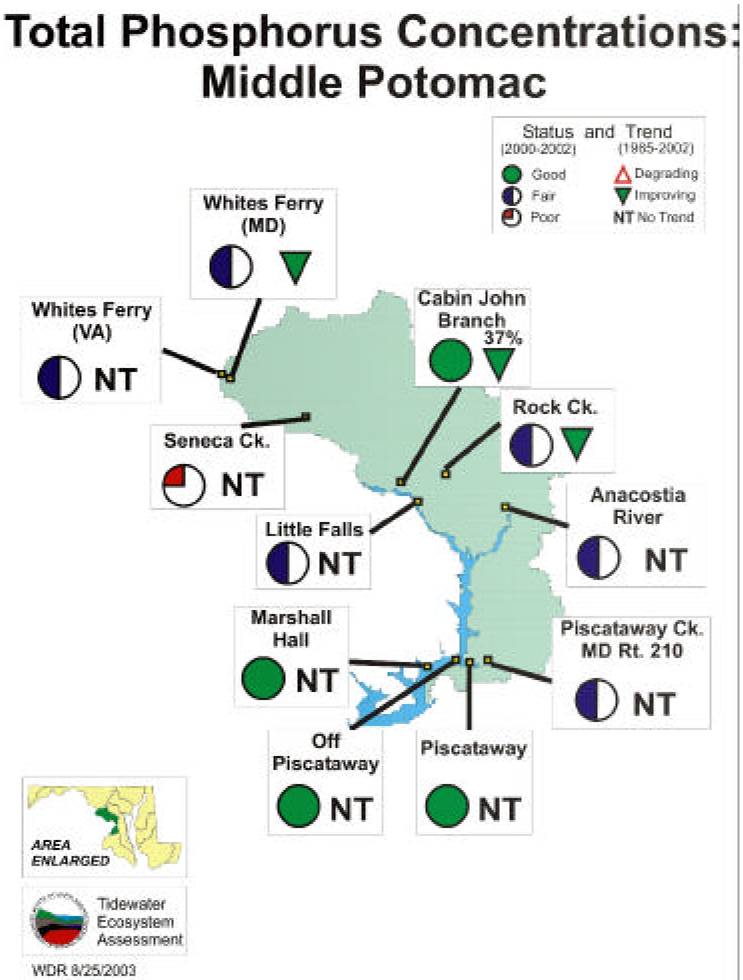


Figure MPR8 – Abundance of Algae in the Middle Potomac River Basin.

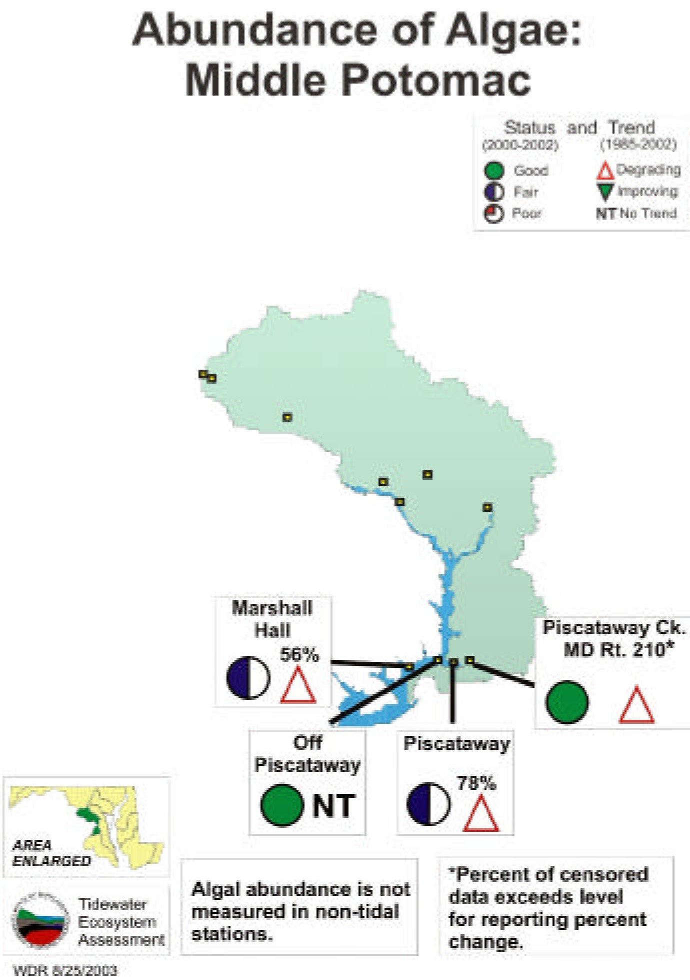


Figure MPR9 – Total Suspended Solids Concentrations in the Middle Potomac River Basin.

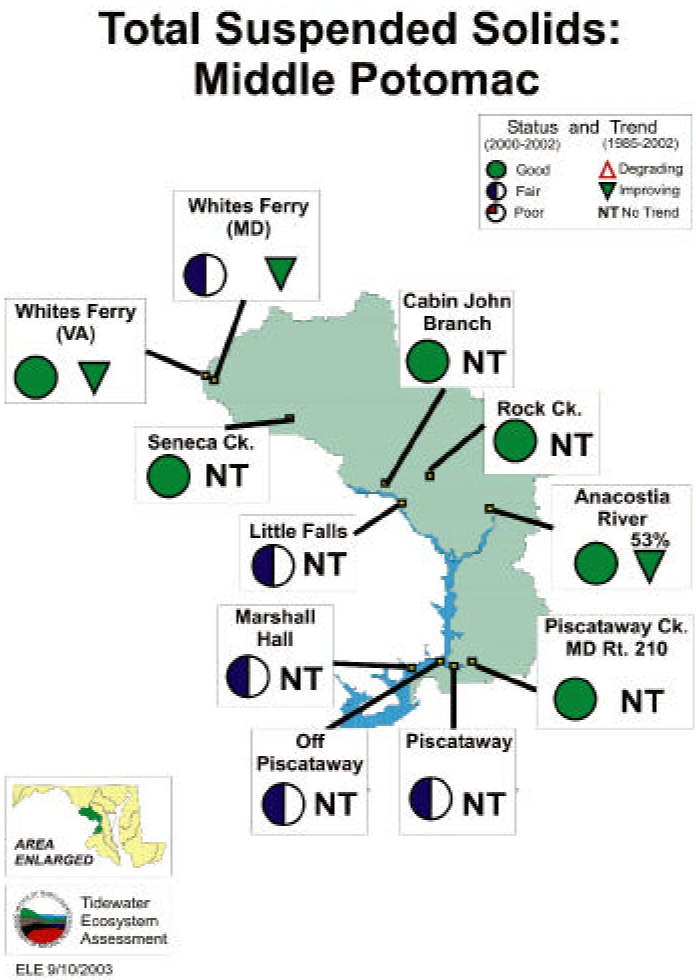


Figure MPR10 – Water Clarity (Secchi Depth) in the Middle Potomac River Basin.

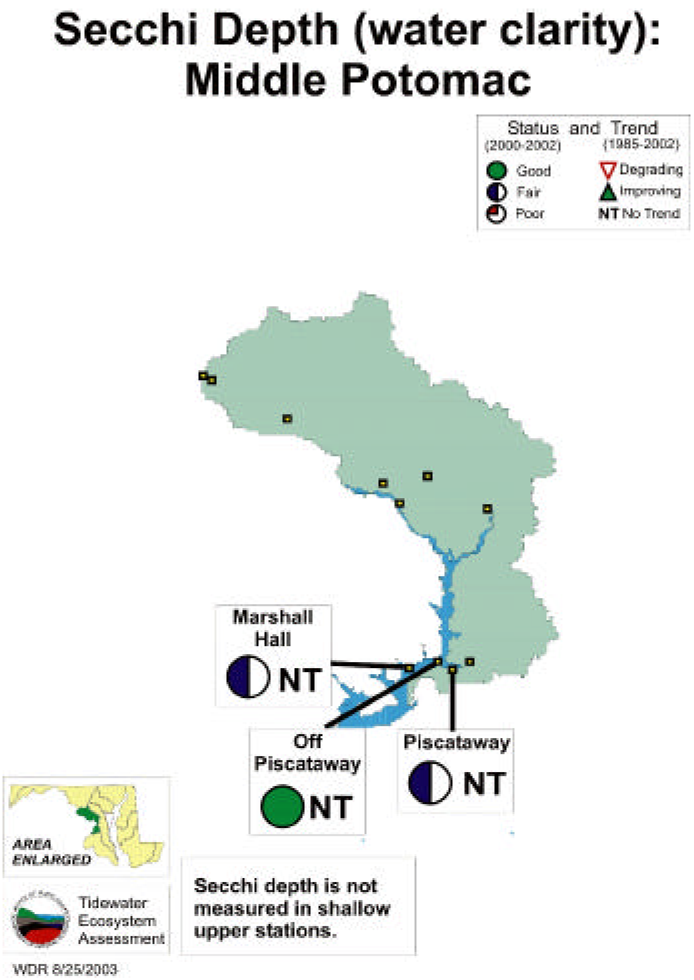
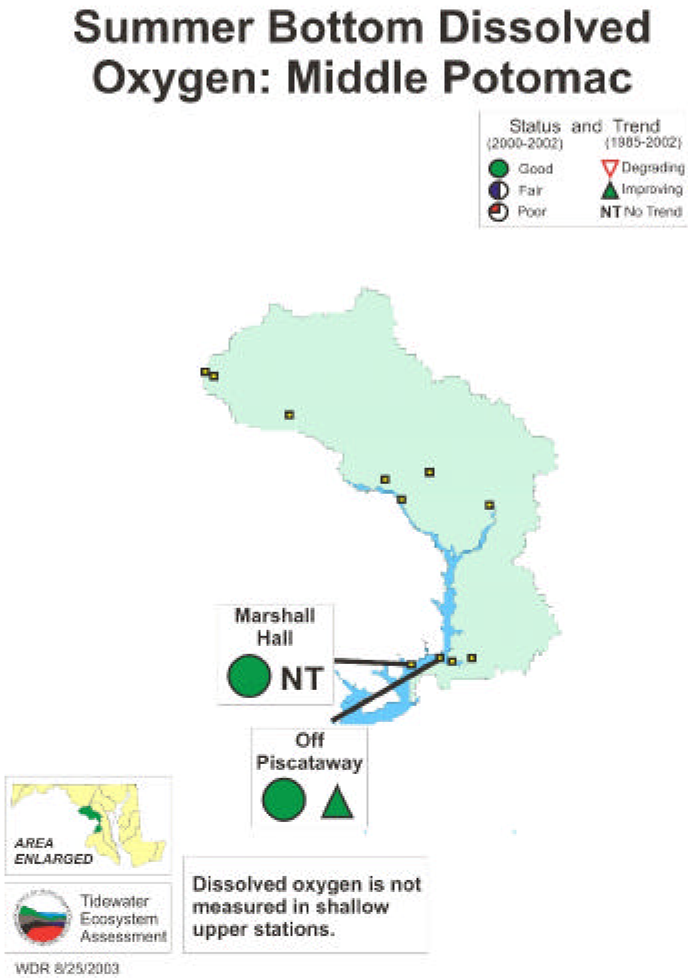


Figure MPR 11 – Summer Bottom Dissolved Oxygen in the Middle Potomac River Basin.



Overview of Monitoring Results

Water and Habitat Quality

Non-tidal Water Quality Monitoring Information Sources

Much useful information on non-tidal water quality is available on the Internet. The State of Maryland's Biological Stream Survey (MBSS) basin fact sheets and basin summaries are available at: **http://www.dnr.state.md.us/streams/mbss/mbss_fs_table.html** MBSS also reports stream quality information summarized by county at: **http://www.dnr.state.md.us/streams/mbss/county_pubs.html** In addition to these reports and fact sheets, detailed and more recent information and data are also available on the MBSS website: **http://www.dnr.state.md.us/streams/mbss**

Find information on the Montgomery Countywide Stream Protection Strategy at: **http://www.montgomerycountymd.gov/siteHead.asp?page=/mc/services/dep/index.html**

Information on Prince George's County water quality monitoring and stream assessments are available at: **http://www.co.pg.md.us/Government/AgencyIndex/DER/PPD/Environment_Protection/water_quality.asp?h=20&s=40&n=50&n1=150**

Water quality information collected by Maryland's volunteer Stream Waders is available at: **http://www.dnr.state.md.us/streams/mbss/mbss_volun.html**

Long-term Water Quality Monitoring

Good water quality is essential to support the animals and plants that live or feed in the tributaries. Parameters measured include nutrients, algal abundance, total suspended solids, water clarity (Secchi depth), and dissolved oxygen.

Current status is determined based on the most recent three-year period (2000-2002). For dissolved oxygen, the current levels are compared to ecologically meaningful thresholds to assign a status of good, fair, or poor. Thresholds have not been established for the other parameters, so the current data are compared to a baseline data set, and assigned a status of good, fair, or poor, which is only a *relative* status compared to the baseline data. Long-term rends are determined using a non-parametric test for trend (the Seasonal Kendall test). For a detailed description of the methods used to determine status and trends, see http://www.dnr.state.md.us/bay/tribstrat/status_trends_methods.html.

Total nitrogen levels have improved (decreased) at all Middle Potomac stations during the 1985-2002 period, but most stations show no improvement in total phosphorus, total suspended solids, or water clarity. Unfortunately, algal abundance has worsened (increased) at several stations, and dissolved oxygen levels have worsened (decreased) at the Off Piscataway station.

SAV (Bay Grasses)

The well-defined linkage between water quality and submerged aquatic vegetation (SAV) distribution and abundance make SAV communities good barometers of the health of estuarine ecosystems. SAV is important not only as an indicator of water quality, but it is also a critical nursery habitat for many estuarine species. Blue crab post-larvae are 30 times more abundant in SAV beds than adjacent unvegetated areas. Similarly, several species of waterfowl are dependant on SAV as food when they over-winter in the Chesapeake region.

The Chesapeake Bay Program has developed new criteria for determining SAV habitat suitability of an area based on water quality. The APercent Light at Leaf@ habitat requirement assesses the amount of available light reaching the leaf surface of SAV after being attenuated in the water column and by epiphytic growth on the leaves themselves. The document describing this new model is found on the Chesapeake Bay Program website (www.chesapeakebay.net/pubs/sav/index.html). The older AHabitat Requirements@ of five water quality parameters are still used for diagnostic purposes. Re-establishment of SAV is measured against the ATier 1 Goal@, an effort to restore SAV to any areas known to contain SAV from 1971 to 1990.

The tidal fresh Potomac River has had highly variable SAV coverage, according to the Virginia Institute of Marine Science (VIMS) annual aerial survey (www.vims.edu/bio/sav/), peaking in 1991 at 4,632 acres, or 72 percent of the 6,405 acre Tier I goal (Figure MPR12). From this high, SAV abundance decreased to a low of 1,369 acres in 1997 and rebounded in 1998, 1999 and 2000 to reach 3,879 or 61 percent of the Tier I goal. In 2001, the reported figure (1,969 acres) is down 50 percent from the 2000 number, however, it is important to remember that flight restrictions imposed after September 11, 2001 prevent VIMS from getting complete coverage. The SAV beds fringe many of the shorelines. Ground-truthing by citizens, U. S. Geological Survey, U. S. Fish and Wildlife Service and VIMS has found 11 species of SAV in this region, with wild celery, hydrilla and milfoil being the most reported ones. Data obtained from water quality monitoring stations located near Sheridan Point indicate that suspended solid levels pass, algae and phosphorous levels are borderline and light attenuation and percent light at leave fail the SAV habitat requirements. Nitrogen concentration is not applicable in tidal fresh regions for SAV habitat requirements.

Piscataway Creek has had increases in SAV coverage since 1995, though 1999 showed a large decrease from the 1998 levels (www.vims.edu/bio/sav/). The Tier I goal for this segment is 835 acres and the 1999 and 2000 SAV coverages were 15 percent and 38 percent of this number, respectively (Figure MPR12), with the 2000 coverage being the most ever reported by the VIMS survey. In 2001, no data were obtained, again due to flight restrictions resulting from the terrorist attacks of 2001. Most of the 2000 SAV beds fringe the southern shore and the headwaters of this creek. Ground-truthing by citizens and staff from the U. S. Geological Survey has found 7 species in Piscataway Creek, listed in order of frequency recorded; hydrilla, naiads (2 species), coontail, wild celery, water stargrass, and milfoil. Water quality data from the station located near Calvert Manor indicate that algae levels and suspended solids pass in respect to the SAV habitat requirements (Figure MPR12). Light attenuation, percent light at leaf and phosphorous levels fail these requirements. Nitrogen concentration is not applicable in tidal fresh regions.

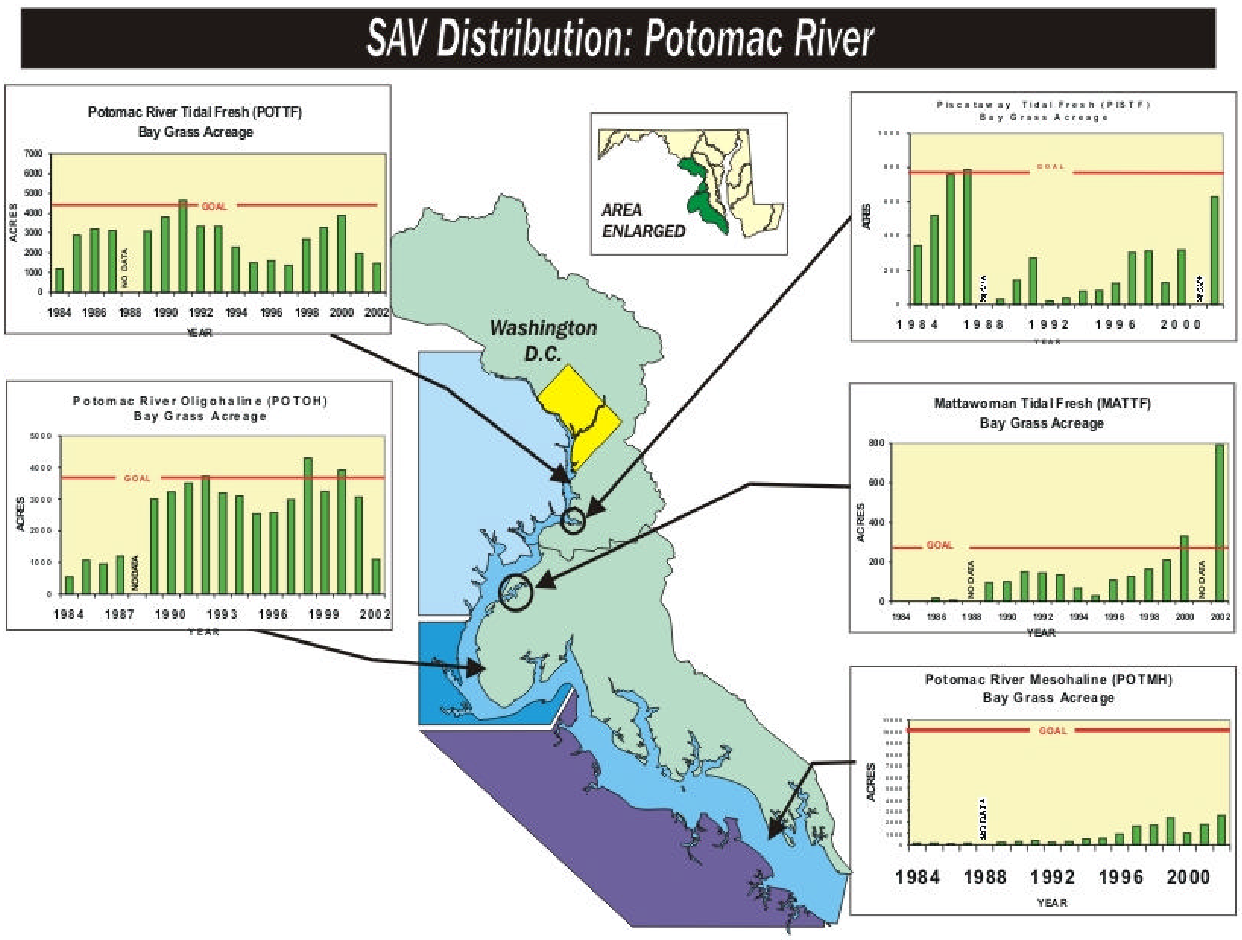
Mattawoman Creek has had steady increases in SAV coverage since 1995 (Figure MPR12), surpassing the Tier I goal (134 acres) in 1998 (163 acres), 1999 (210 acres) and 2000 (331 acres or 247 percent of the goal) (www.vims.edu/bio/sav/). No data were obtained for 2001, again due to flight restrictions. Most of the previously identified beds fringe the shoreline, upstream of Swedes and Deep Points. Extensive ground-truthing by staff from the U. S. Geological Survey, U. S. Fish and Wildlife Service and citizens from Friends of Mattawoman Creek has found hydrilla, naiads, wild celery, coontail and milfoil (in order of frequency reported) in this creek. Water quality monitoring data from the station located near Swedes Point indicate that phosphorous and suspended solids levels meet and algae levels are borderline to the SAV habitat requirements. Light attenuation and percent light at leaf fail the requirements. Nitrogen concentration is not applicable in this tidal fresh creek.

In the oligohaline (low salinity) Potomac River, between Quantico and Mathias Points, has seen fairly consistent SAV coverage since 1984, ranging from a low of 2,529 acres in 1995 to a high of 4,306 acres in 1998 (Figure MPR12), at which time the coverage exceeded the Tier I goal of 4,264 acres (www.vims.edu/bio/sav/). The 2001 coverage was 3,071 acres or 72 percent of the Tier I goal, though again these are partial data. The largest SAV beds in the Maryland portion of the river are found in Chicamuxen Creek and then fringing the shoreline to Smith Point, then fringing the shoreline from Maryland Point to just upstream of Pope Creek, including the shorelines of Nanjemoy Creek and Port Tobacco River. On the Virginia side, there are fringing beds from Shipping to Clifton Points, near the mouth of Potomac Creek, near Somerset Beach, the mouth of Chotank Creek, and fringing the shoreline around Mathias Point. Ground-truthing by citizens and staff from U. S. Geological Survey, U. S. Fish and Wildlife Service and Virginia Institute of Marine Science has found 13 different species of SAV, with the three most often reported being milfoil, wild celery, hydrilla. Water quality data from the monitoring stations near Moss and Maryland Points indicate that only algae levels meet the SAV habitat requirements, percent light at leaf and concentration of suspended solids are borderline and light attenuation and phosphorus levels fail. Nitrogen concentration is not applicable in this area for SAV habitat requirements.

In the mesohaline (moderate salinity) Potomac River, downstream of Mathias point to Point Lookout has had steady increases in SAV coverage since 1992 (when there was 238 acres), passing the Tier I goal of 989 acres and reaching the highest recorded level in 1999 of 2,351 acres (or 238 percent of the Tier I goal) (www.vims.edu/bio/sav/) However, the 2000 coverage was down 55 percent to 1,045 acres due to heavy springtime algal booms, but even this value exceeds the Tier I goal (Figure MPR12). In 2001, SAV coverage rebounded to 1,739 acres or 176 percent of the Tier I goal. On the Maryland side, there are fringing beds from the Route 301 bridge to Cobb Island, scattered throughout the Wicomico River and St. Clements Bay. There are a few small beds downstream from here, but no large beds until St. George Island with fringing beds through much of the lower St. Mary's River. On the Virginia side, there is a large fringing bed from Mathias Point to the Upper Machodoc Creek. Ground-truthing by citizens and staff from Patuxent River Park, Patuxent Naval Air Station, U. S. Geological Survey, U. S. Fish and Wildlife Service and VIMS has identified 11 species with milfoil, horned pondweed and wild celery the three most frequently reported ones. Data from the three water quality monitoring stations (located at the Route 301 bridge, near

Ragged Point and Point Lookout) indicates that water quality is fairly good in this area with light attenuation and nitrogen levels being borderline, while percent light at leaf, concentrations of suspended solids, algae and phosphorous pass the SAV habitat requirements.

Figure MPR12 – Bay Grasses (Submerged Aquatic Vegetation) Distribution in the Potomac Basin.



Benthic Community

The benthic community forms an integral part of the ecosystem in estuarine systems. For example, small worms and crustaceans are key food items for crabs and demersal fish, such as spot and croaker. Suspension feeders that live in the sediments, such as clams, can be extremely important in removing excess algae from the water column. Benthic macroinvertebrates are reliable and sensitive indicators of estuarine habitat quality.

Benthic monitoring includes both probability-based sampling (sampling sites are selected at random) and fixed station sampling (the same site is sampled every year). A benthic index of biotic integrity (B-IBI) is determined for each site (based on abundance, species diversity, etc.). The B-IBI serves as a single-number indicator of benthic community health. For more details on the methods used in the benthic monitoring program, see http://esm.versar.com/Vcb/Benthos/backgrou.htm.

For the period 1994-2000, the tidal freshwater Potomac River suffered primarily from excess abundance of organisms, which is often indicative of organic enrichment. Significant trends in the B-IBI were detected at the Rosier Bluff long-term benthic monitoring station. The Rosier Bluff station exhibited significantly improving conditions over the period 1985-2000 (Figure MPR13). Benthic community status was good at this station.

Improving trends in the tidal freshwater portion of the Potomac River can be attributed to a substantial decrease in densities of the dominant bivalve *Corbicula fluminea*, which peaked in the late 1980s. Also, oligochaete abundance (mostly *Limnodrilus hoffmeisteri*) has decreased over the long-term monitoring period. The improving benthic condition at the Rosier Bluff station is most likely related to improvements in nutrient loadings. High levels of nutrients can lead to high levels of organic matter available for the benthos. Under these conditions the benthic community responds with increased abundance and biomass of opportunistic species over reference values.

Figure MPR13. Number of sites failing the B-IBI and probabilities (and SE) of observing degraded benthos, non-degraded benthos, or benthos of intermediate condition (indeterminate for low salinity habitats) for Potomac River Basin segments, 1994-2000. See Table 1 for additional information. Segments codes: TF = tidal freshwater.

Segment	River	Number of Sites	Sites with B-IBI<3.0	P Deg.	P Non-deg.	P Interm.
POTTF	Potomac	19	9	43.5 (10.3)	17.4 (7.9)	47.8 (10.4)

Figure MPR14. Trends in benthic community condition at Potomac River Basin long-term monitoring stations, 1985-2000. Trends were identified using the van Belle and Hughes (1984) procedure. Current mean B-IBI and condition are based on 1998-2000 values. Initial mean B-IBI and condition are based on 1985-1987 values. NS: not significant.

Station[1]	Trend Significance	Median Slope (B-IBI units/yr)	Current Condition (1998-2000)	Initial Condition (1985-1987)
36	$p < 0.01$	0.07	4.22 (Meets Goal)	3.20 (Meets Goal)

[1]Sta. 36, Rosier Bluff, tidal freshwater, 38.769781 lat., 77.037531 long.

Nutrient Limitation

Like all plants, phytoplankton need nitrogen, phosphorus, light, and suitable water temperatures to grow. If light is adequate and the water temperature is appropriate, phytoplankton will continue to grow as long as unlimited amounts of nutrients are available. If nutrients are not unlimited, then the ratio of nitrogen to phosphorus affects phytoplankton growth. (Phytoplankton generally use nitrogen and phosphorus at a ratio of 16:1, that is, 16 times as much nitrogen is needed as phosphorus. This is called the Redfield ratio.) If one of the nutrients is not available in the adequate quantity, phytoplankton growth is 'limited' by that nutrient. If both nutrients are available in enough excess (regardless of the relative proportion of them) that the phytoplankton can not use them all even when they are growing as fast as they can under the existing temperature and light conditions, then the system is 'nutrient saturated.'

Nitrogen limitation occurs when there is insufficient nitrogen, i.e., there is excess phosphorus. Nitrogen limitation often happens in the summer and fall after stormwater flows are lower (so less nitrogen is being added to the water) and some of the nitrogen has already been used up by phytoplankton growth during the spring. If an area is nitrogen limited, then adding nitrogen will increase phytoplankton growth.

Phosphorus limitation occurs when there is insufficient phosphorus, i.e. there is excess nitrogen. If an area is phosphorus limited, then adding phosphorus will increase phytoplankton growth. Phosphorus limitation occurs in some locations in the spring when large amounts of nitrogen are added to the estuary from stormwater flow.

If an area is nutrient saturated, then both nitrogen and phosphorus are available in excess. In this case, if phytoplankton are exposed to appropriate water temperatures and sufficient light, they will grow. If an area is both nitrogen and phosphorus limited, then both nitrogen and phosphorus must be added to increase algal growth.

Managers can use the nutrient limitation model to predict which nutrient is limiting at a given location and use the information to assess what management approach might be the most effective for controlling excess phytoplankton growth. If an area is phosphorus limited, then reducing phosphorus will bring the most immediate reductions in phytoplankton grown. However, if nitrogen levels are not also reduced, the excess nitrogen that goes unused can be exported downstream. This excess nitrogen may reach an area that is nitrogen limited, fueling phytoplankton growth in that downstream area.

The nutrient limitation predictions are a valuable tool, but they must be used in conjunction with other water quality and watershed information to fully assess and evaluate the best management approach.

The nutrient limitation model was used to predict nutrient limitation for four stations in the tidal portion of the middle Potomac River Basin. Results for each station are summarized for the most recent three-year period (2000-2002) by season: winter (December-February), spring (March-May), summer (July-September) and fall (October-November). On an annual basis, phytoplankton growth is nutrient saturated approximately 95 percent of the time at all four stations (Piscataway Creek, Piscataway, Off Piscataway, and Marshall Hall). See Appendix B for details.

Appendix A – Nutrient Loadings from Major Wastewater Treatment Facilities in the Middle Potomac River Basin

Figure A1 - Mean daily total nitrogen load and flow for the Blue Plains treatment plant.

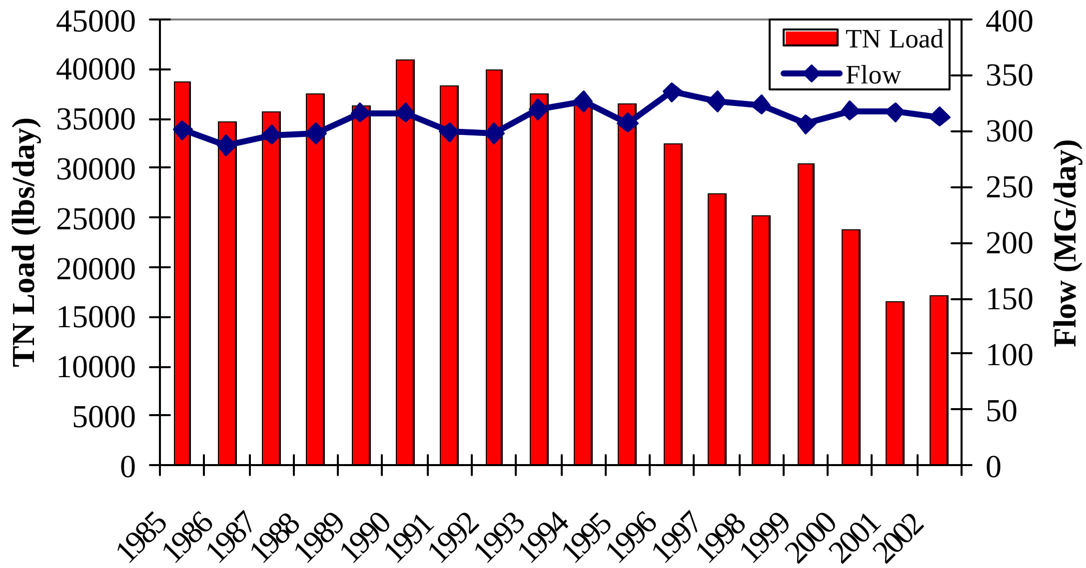


Figure A2 – Mean daily total phosphorus load and flow for the Blue Plains treatment plant.

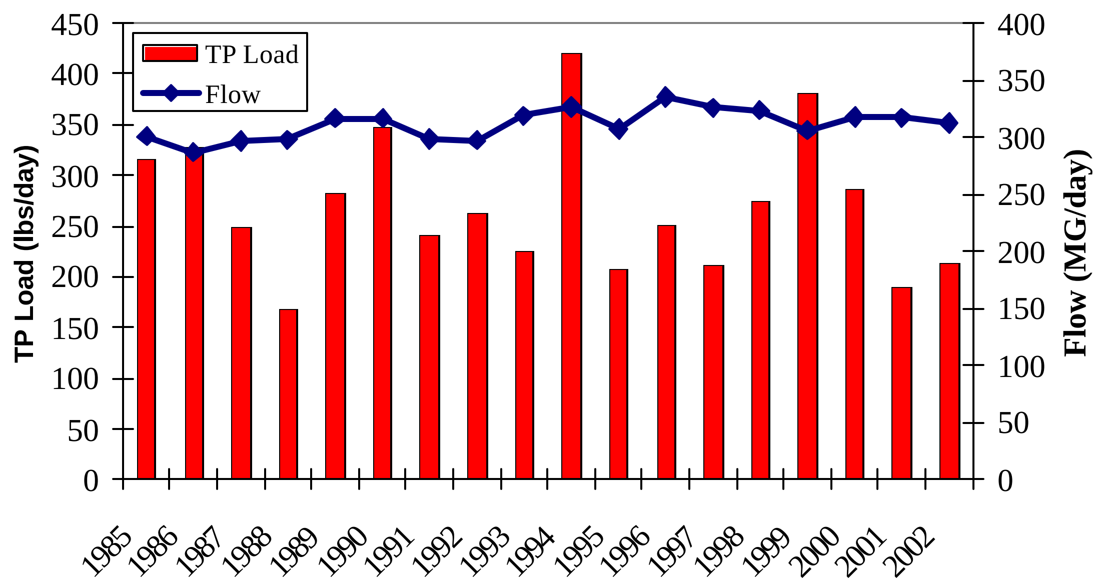


Figure A3 - Mean daily total nitrogen load and flow for the Damascus treatment plant.

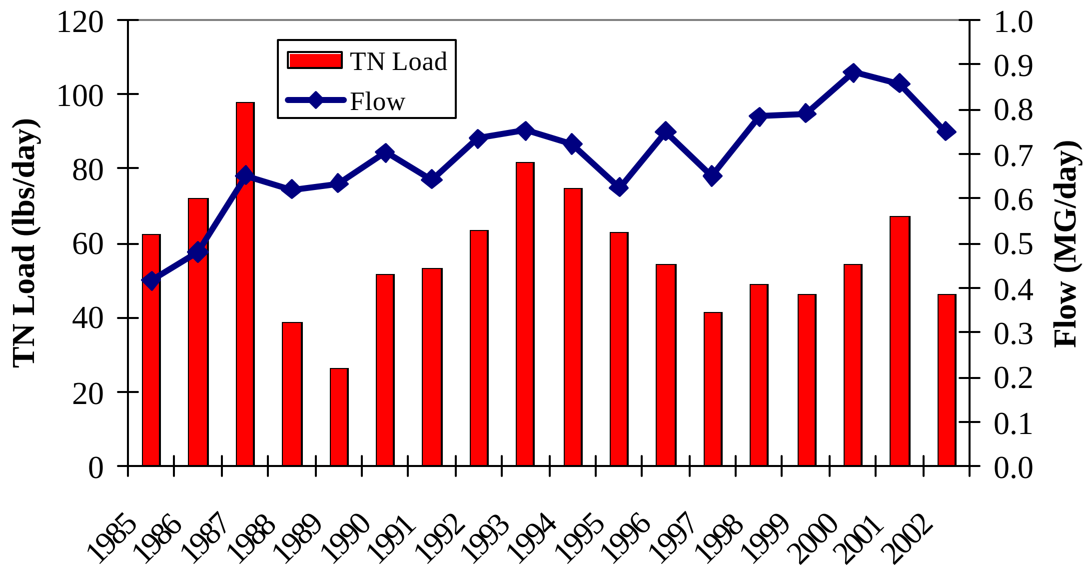


Figure A4 - Mean daily total phosphorus load and flow for the Damascus treatment plant.

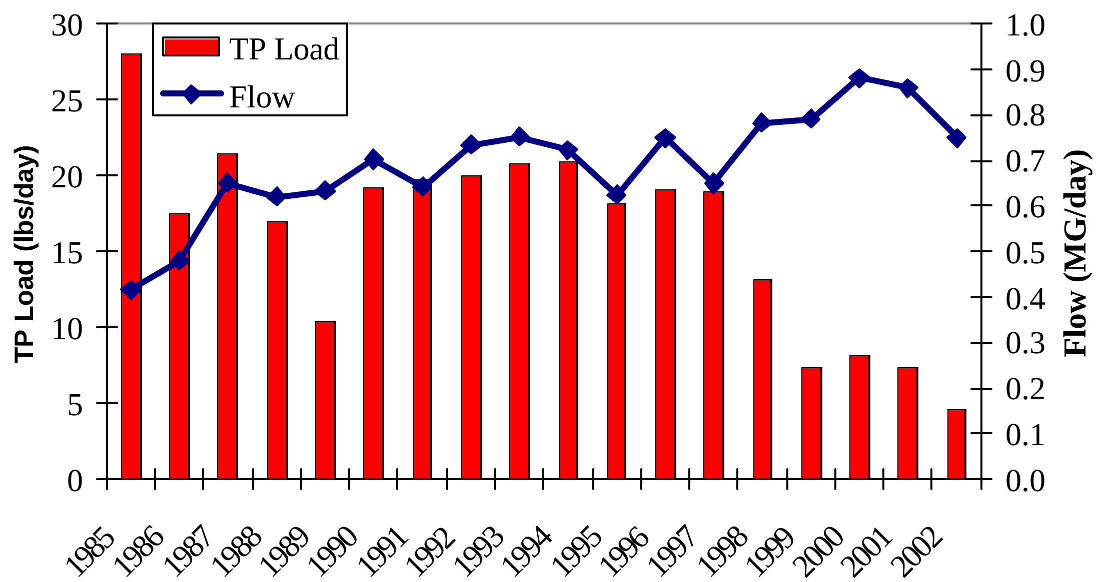


Figure A5 - Mean daily total nitrogen load and flow for the Piscataway treatment plant.

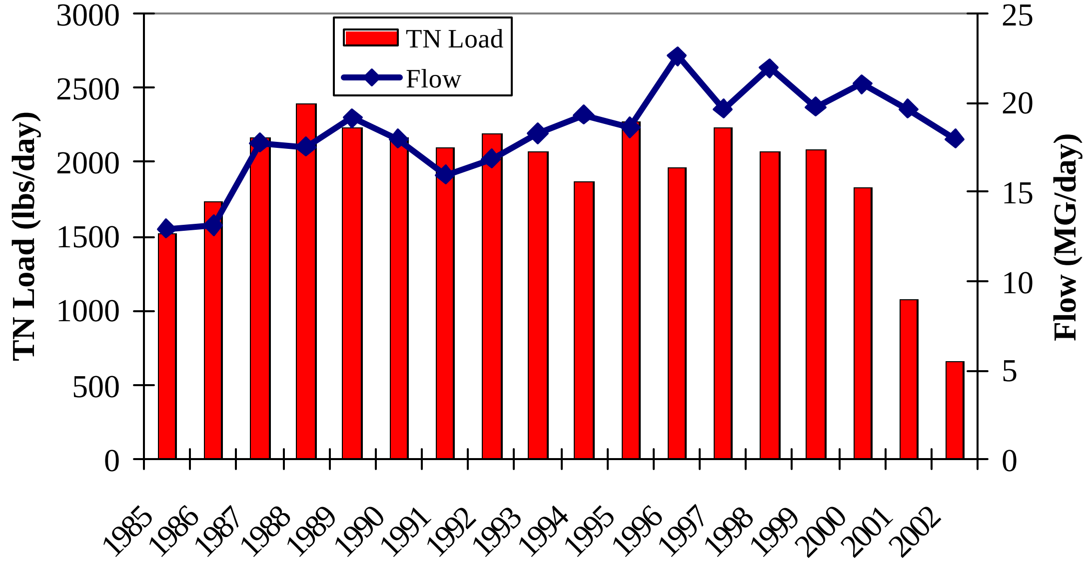


Figure A6 - Mean daily total phosphorus load and flow for the Piscataway treatment plant.

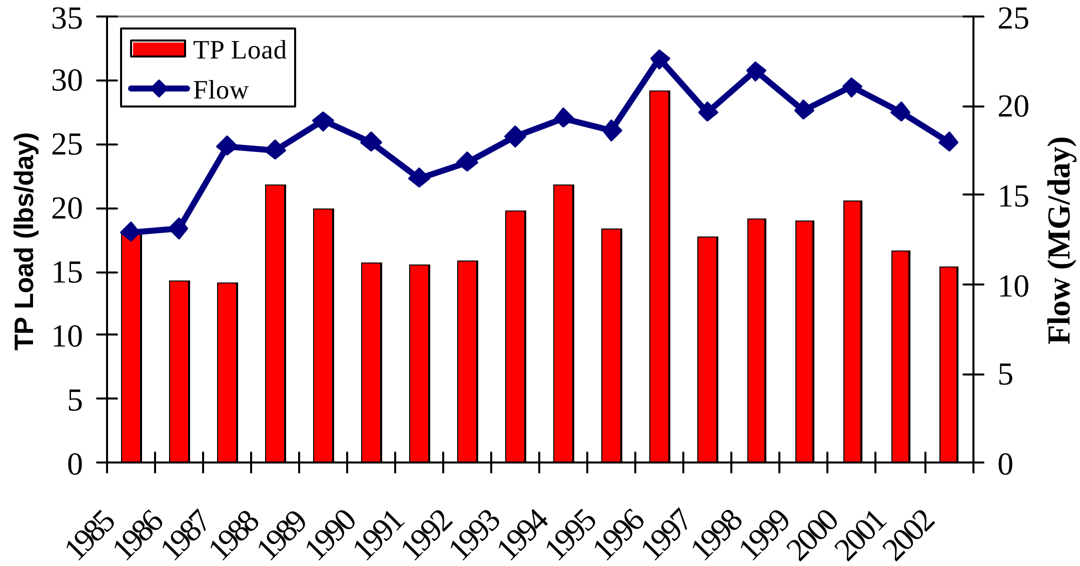


Figure A7 - Mean daily total nitrogen load and flow for the Poolesville treatment plant.

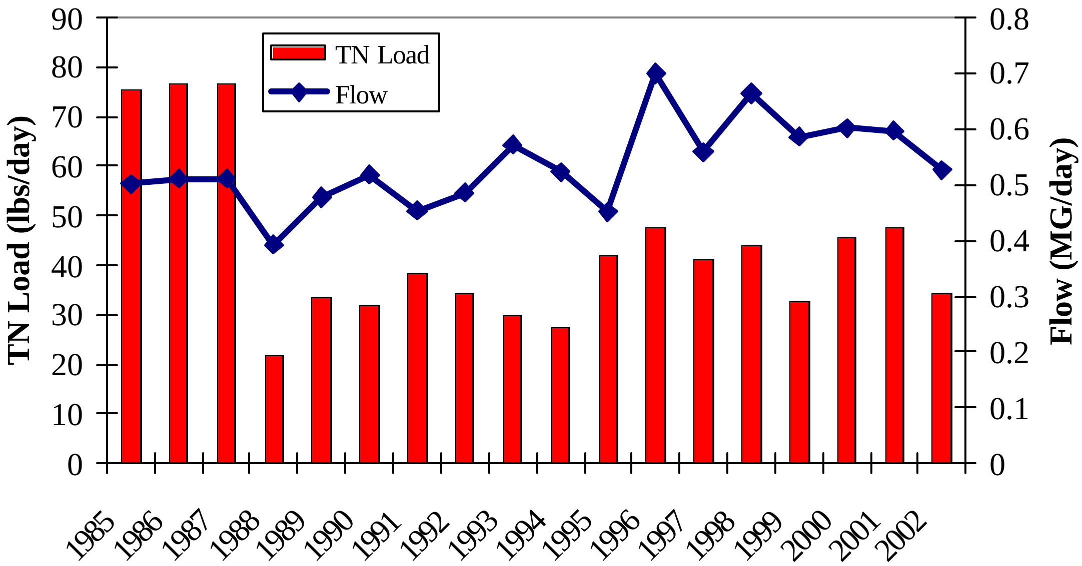


Figure A8 - Mean daily total phosphorus load and flow for the Poolesville treatment plant.

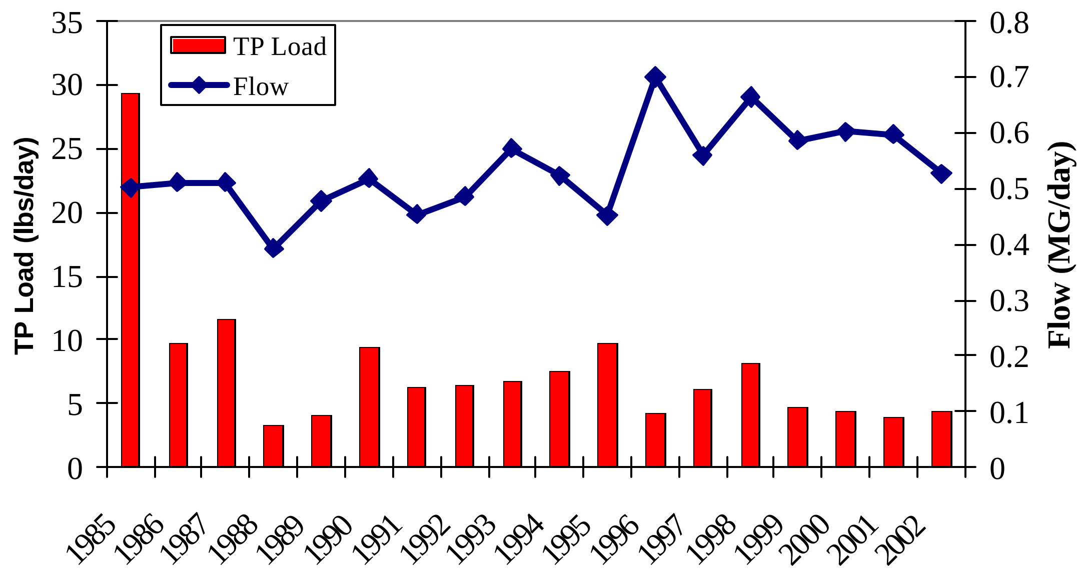


Figure A9 - Mean daily total nitrogen load and flow for the Seneca treatment plant.

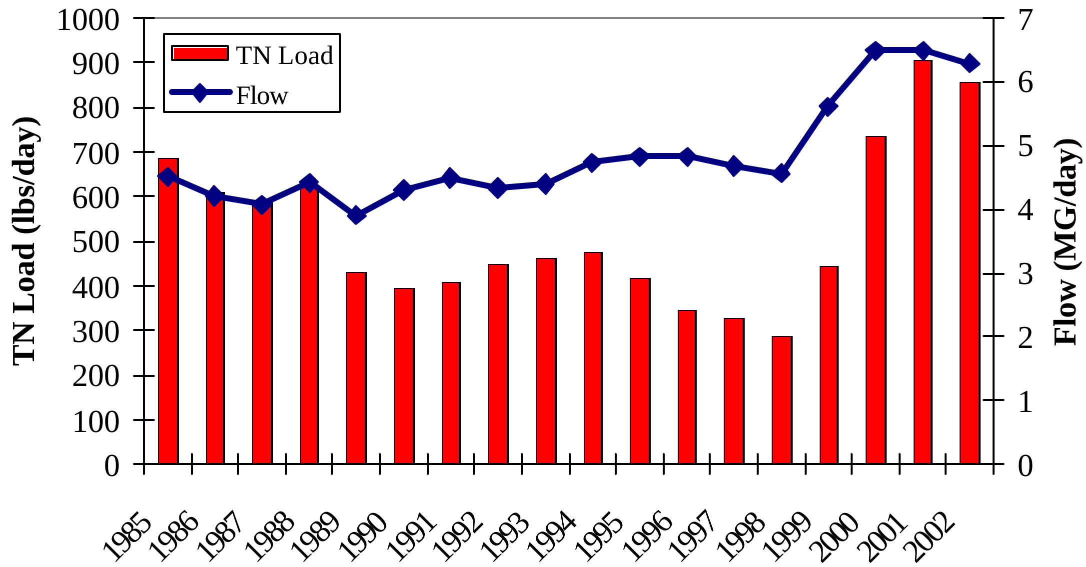


Figure A10 - Mean daily total phosphorus load and flow for the Seneca treatment plant.

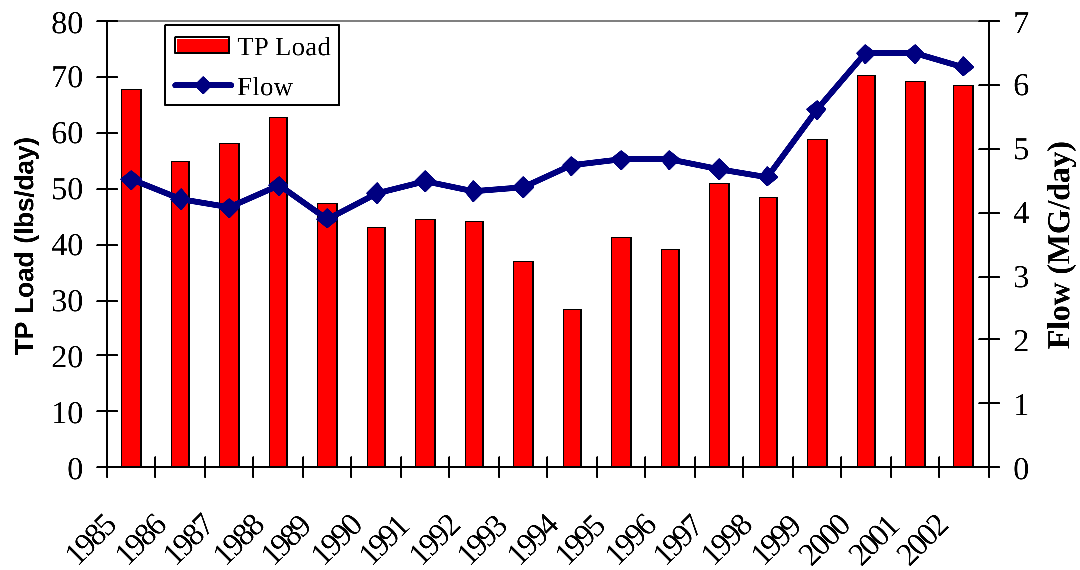


Figure A11 - Percent of total nitrogen load discharged by major plants.

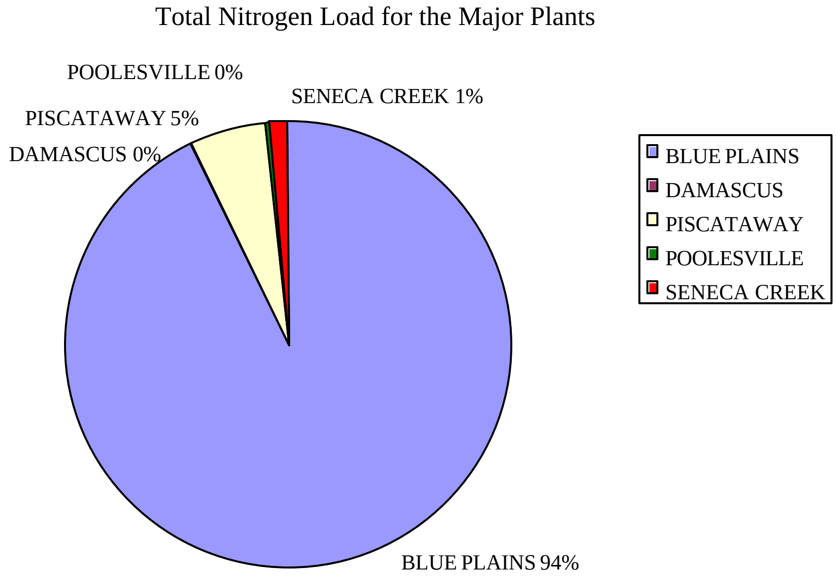


Figure A12 - Percent of total phosphorus load discharged by major plants.

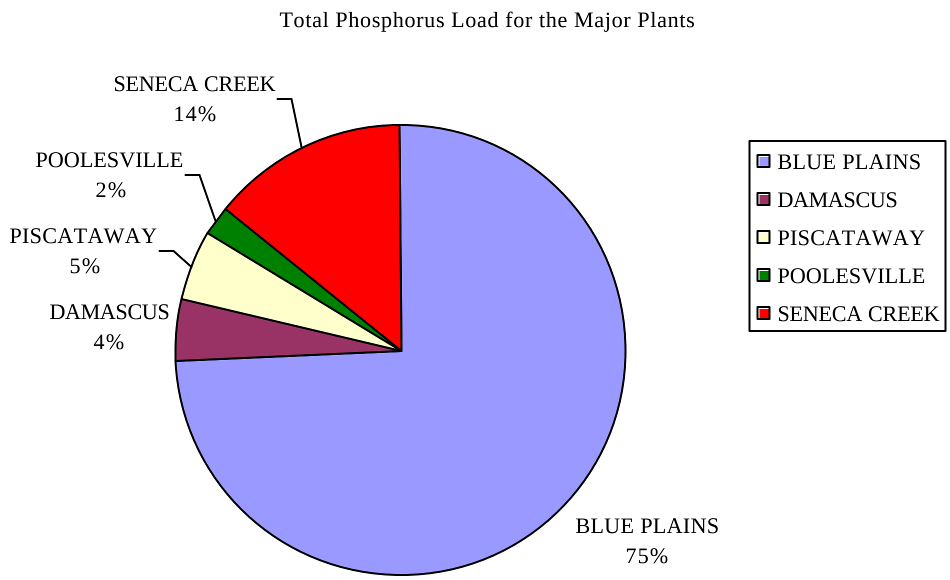


Figure A13 - Total nitrogen loads and flow for all major treatment plants.

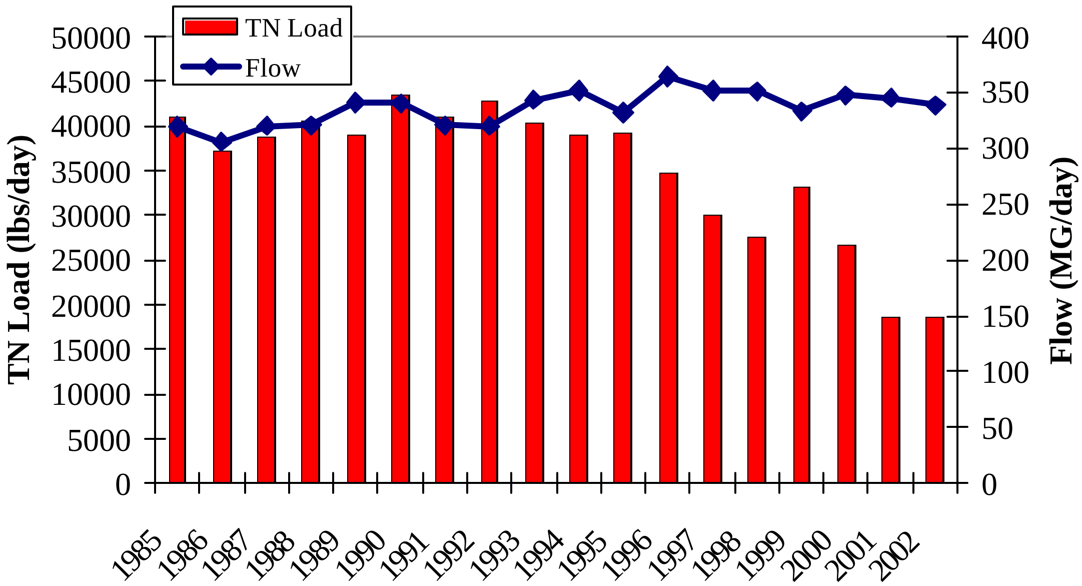
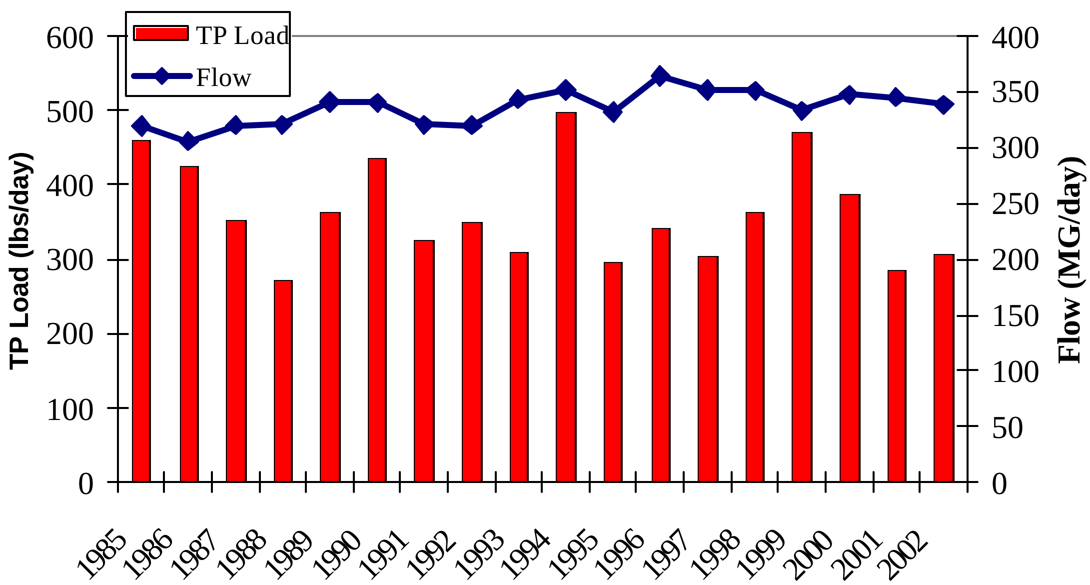


Figure A14 - Total phosphorus loads and flow for all major treatment plants.

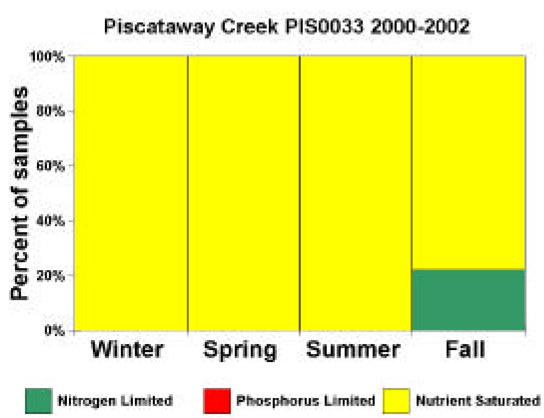


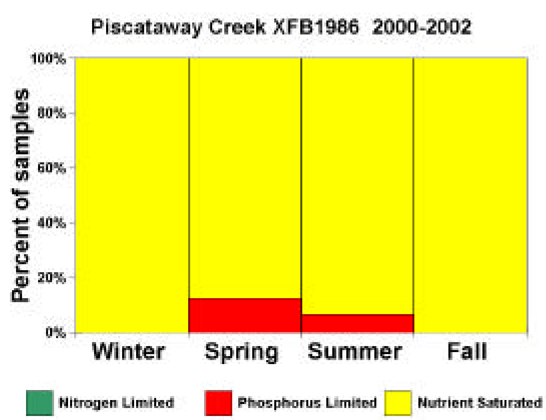
Appendix B – Nutrient Limitation Graphs for the Middle Potomac River Basin

The nutrient limitation model was used to predict nutrient limitation for four stations in the Middle Potomac Basin. Results for each station are summarized for the most recent three-year period (2000-2002) by season: winter (December-February), spring (March-May), summer (July-September) and fall (October-November). Overall, flow is a strong factor in determining seasonal limitation patterns throughout the river. The uppermost stations show patterns typical of turbid, nutrient enriched areas where nutrient limitation occurs primarily in the warmer/low river flow.

Managers can use these predictions to assess what management approach will be the most effective for controlling excess phytoplankton growth. Interpreting the results can be a little counter-intuitive, however. Remember that nitrogen limited means that *phosphorus* is in excess. Initially, it would seem that the best management strategy would be to reduce phosphorus inputs. However, it may actually be more cost effective to further reduce *nitrogen* inputs to increase the amount of 'unbalance' in the relative proportions of nutrients so that phytoplankton growth is even more limited. When used along with other information available from the water quality and watershed management programs, these predictions will allow managers to make more cost-effective management decisions.

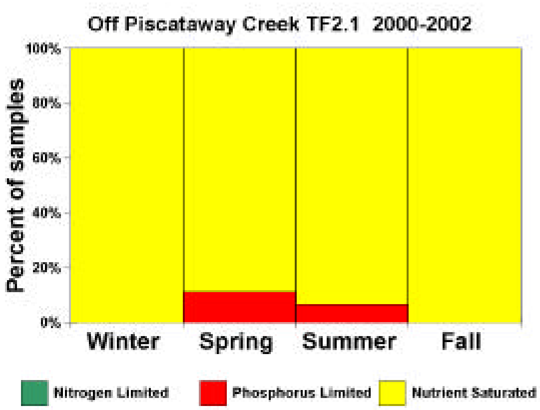
Upper Piscataway Creek (PIS0033) – On an annual basis, phytoplankton growth is nutrient saturated (light limited or no limitation) more than 95% of the time. In the fall, there is nitrogen limitation approximately 20% of the time. Total and dissolved inorganic nitrogen concentrations are relatively good and improving (decreasing). Total phosphorus concentration is relatively fair; dissolved inorganic phosphorus concentration is poor but improving (decreasing). The ratio of total nitrogen to total phosphorus is decreasing. Dissolved inorganic nitrogen to dissolved inorganic phosphorus ratio is relatively low in the spring, summer and fall. Together, this information suggests that further reductions in nitrogen concentrations will help limit phytoplankton growth at this location. Reductions in phosphorus concentrations in all seasons are needed to bring the system into better balance and to potentially limit growth in the spring.

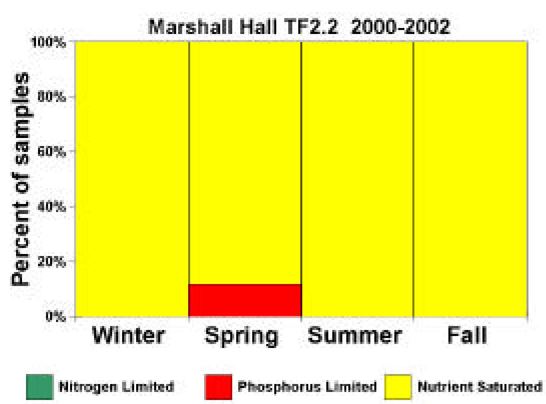




Lower Piscataway Creek (XFB1986) –On an annual basis, phytoplankton growth is nutrient saturated (light limited or no limitation) almost 95% of the time. There is phosphorus limitation for a small percentage of the time in the spring and summer (approximately 10% and less than 10%, respectively). Fall and winter growth is always nutrient saturated. Total and dissolved inorganic nitrogen concentrations are relatively poor but improving (decreasing). Total phosphorus concentration is relatively good and dissolved inorganic phosphorus concentration is relatively fair. The ratio of total nitrogen to total phosphorus and the ratio of dissolved inorganic nitrogen to dissolved inorganic phosphorus are both decreasing. The dissolved inorganic nitrogen to dissolved inorganic phosphorus ratio is relatively high, particularly in the winter. Together, this information suggests that reductions in phosphorus in all seasons will help to limit phytoplankton growth at this location. Much larger nitrogen reductions will be needed to allow nitrogen limitation in this portion of Piscataway Creek.

Off Piscataway Creek (TF2.1) - On an annual basis, phytoplankton growth is nutrient saturated (light limited or no limitation) almost 95% of the time. There is phosphorus limitation for a small percentage of the time in the spring and summer (approximately 10% and less than 10%, respectively). Fall and winter growth is always nutrient saturated. Total and dissolved inorganic nitrogen concentrations are relatively poor but improving (decreasing). Total phosphorus concentration is relatively good and dissolved inorganic phosphorus concentration is relatively fair. The ratio of total nitrogen to total phosphorus and the ratio of dissolved inorganic nitrogen to dissolved inorganic phosphorus are both decreasing. The dissolved inorganic nitrogen to dissolved inorganic phosphorus ratio is moderate except in the winter when it is relatively high. Together, this information suggests that reductions in phosphorus in all seasons will help to limit phytoplankton growth at this location. Large nitrogen reductions will be needed to help bring the system into better balance and may lead to nitrogen limitation in the summer and fall.





Marshall Hall (TF2.2) - Phytoplankton growth is nutrient saturated (light limited or no limitation) more than 95% of the time at this station. Spring growth is phosphorus limited approximately 10% of the time. Total and dissolved inorganic nitrogen concentrations are relatively poor but improving (decreasing). Total phosphorus concentration is relatively good and dissolved inorganic phosphorus concentration is relatively fair. The ratio of total nitrogen to total phosphorus and the ratio of dissolved inorganic nitrogen to dissolved inorganic phosphorus are both decreasing. The dissolved inorganic nitrogen to dissolved inorganic phosphorus ratio is moderate except in the winter when it is relatively high. Together, this information suggests that reductions in phosphorus in all seasons will help to limit phytoplankton growth at this location. Larger nitrogen reductions will be needed to help bring the system into better balance and may lead to nitrogen limitation in the summer and fall.

Appendix C – References

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